

UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION  
OFFICE OF NUCLEAR REACTOR REGULATION  
Jennifer L. Uhle, Deputy Director

In the Matter of All General Electric Mark I Boiling-Water Reactors Operating Licensees

**DIRECTOR'S DECISION UNDER 10 CFR 2.206**

**I. Introduction**

On April 13, 2011, Mr. Paul Gunter, along with Mr. Kevin Kamps, of Beyond Nuclear (the petitioner) submitted a petition under Title 10, "Energy," of the *Code of Federal Regulations* (10 CFR) 2.206, "Requests for action under this subpart," to the Executive Director for Operations of the U.S. Nuclear Regulatory Commission (NRC or the Commission) (Agencywide Documents Access and Management System (ADAMS) Accession No. ML11104A058).

The petitioner requested that the NRC order the immediate suspension of the operating licenses of all General Electric (GE) boiling-water reactors (BWRs) that use the Mark I primary containment system. The petitioner cited the Fukushima Dai-ichi accident in Japan as the rationale for and basis of the petition.

On April 19, 2011, the NRC acknowledged receipt of your April 13, 2011, petition. The NRC Petition Review Board (PRB) determined that your request for immediate action is a general assertion without supporting facts. The PRB did not identify a significant safety concern from the information provided that would warrant the NRC to order the immediate suspension of the operating licenses of all GE BWRs with Mark I containments. On April 21, 2011, the NRC informed you of the PRB's decision about the immediate action (ADAMS Accession No. ML11140A078). Subsequently, more than 10,000 copetitioners joined, supporting your petition. Some of the copetitioners provided supplemental information.

On August 16, 2011, the NRC informed you of the PRB's initial recommendations to accept your petition for review in part (ADAMS Accession No. ML112340018). The NRC received from you, and copetitioners, information on numerous and diverse issues that were not raised in your April 13, 2011, letter or during a public meeting held on October 7, 2011.

On December 13, 2011, the NRC informed you of the PRB's final recommendations, accepting parts of your petition for review and rejecting the remaining parts of your petition (ADAMS Accession No. ML11339A077). Based on the NRC's timeline related to its Fukushima lessons-learned review, and because many of your items accepted for review pertained to the Fukushima review, the NRC's review of your petition took longer than the standard of 120 days for reaching a decision on the petition.

The NRC sent a copy of the proposed director's decision to you and to the operating GE BWR licensees with Mark I containments for comment on October 27, 2014. The proposed director's decision is available in ADAMS under Accession No. ML14198A098. The NRC staff did not receive any comments on the proposed director's decision.

## **II. Discussion**

This section includes both the petitioner's requests and the NRC's decisions. The NRC did not issue orders within 90 days of the petition as the petitioner had requested, because we determined that the continued operation of operating reactors did not pose an imminent risk to public health and safety. The NRC also will not be issuing orders in the future based on the petition. The NRC will not be issuing orders because, as explained below, each of the petitioner's requests has been addressed through other actions.

**Request 1: Spent fuel pools (SFPs) elevated to the top of the reactor building outside and above the rated containment structure without safety-related backup electric power systems to cool high-density storage of nuclear waste in the event of loss of grid**

**power.**

**Provide emergency makeup water reliable source.**

**Install additional instrumentation (water level, temperature, and radiation monitoring) on all Mark I storage pools.**

NRC decision: The NRC addressed the petitioner's requests through Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," issued March 12, 2012 (ADAMS Accession No. ML12054A736). This order imposes requirements to maintain or restore SFP cooling capability. This strategy provides makeup water independent of offsite power and the normal emergency alternating current (ac) power sources (e.g., installed emergency diesel generators).

Regarding additional instrumentation for all Mark I spent fuel storage pools, the NRC has addressed this request through Order EA-12-051, "Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," issued on March 12, 2012 (ADAMS Accession No. ML12056A044).

In addition, the petitioner's requests are being addressed through rulemaking (mitigation of beyond-design-basis events rulemaking, NRC-2011-0299). The rulemaking, in part, makes generically applicable the requirements of the mitigation strategies order, giving consideration to lessons learned and feedback from implementation of the order's requirements.

Request 2: **Substandard Mark I pressure suppression containment system vulnerable to early failure under severe accident conditions including over-pressurization.**

NRC decision: In 1972, Dr. S. H. Hanauer, Technical Advisor to the NRC's Executive Director for Operations, wrote a memorandum that raised several questions on the viability of pressure suppression containment concepts. As a result of these concerns, NRC published NUREG-0474, "A Technical Update on Pressure Suppression Type Containments in Use in U.S. Light Water Reactor Nuclear Power Plants." In Enclosure A of this NUREG, a response to each concern of Dr. Hanauer's memorandum of September 20, 1972, was provided. In this NUREG, NRC concluded that licensed Mark I BWR facilities can continue to operate safely, pending completion of the comprehensive Long-Term Program (LTP) evaluation.

The LTP was associated with the suppression pool hydrodynamic loads in BWR facilities with the Mark I containment design. In NUREG-0661, "Safety Evaluation Report, Mark I Containment Long-Term Program," NRC described the generic techniques for the definition of suppression pool hydrodynamic loads in a Mark I system and the related structural acceptance criteria. In the report, NRC staff concluded that "the proposed structural acceptance criteria are consistent with the requirements of the applicable codes and standards and, in conjunction with the structural analysis techniques, will provide an adequate basis for establishing the margins of safety in the containment design." The NRC ordered each licensee on January 13, 1981, to evaluate hydrodynamic loads, and the licensee reflected this in Final Safety Analysis Report Section 3.8 after completing the evaluation/implementation. Therefore, all GE Mark I BWRs were evaluated for the above hydrodynamic loads, and appropriate modifications, if required, were made to maintain the containment structural integrity.

The NRC finds that existing containment vent systems at BWRs with Mark I containments provide a capability to vent the containment under design-basis conditions. The NRC required licensees to enhance the capabilities of the vent system to withstand severe accident conditions through Order EA-12-050, "Order to Modify Licenses with Regard to Reliable Hardened Containment Vents," issued on March 12, 2012 (ADAMS Accession No. ML12054A694), and

superseded by a modified Order EA-13-109, “Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable for Operation under Severe Accident Conditions” (ADAMS Accession No. ML13143A334), issued on June 6, 2013. This order further enhances the reliability of the containment vent system, thereby protecting the containment during severe accident conditions. As a result, BWRs with Mark I containments do not pose an undue hazard to public health and safety, and can continue to operate.

**Request 3: Reactor design in Japan has now dramatically failed to reliably and adequately mitigate and contain significant and mounting radiological releases to the atmosphere, ground water, and the ocean from multiple severe accidents in multiple GE BWR Mark I units.**

**There certainly is much at stake and the seismic issues need to be studied because there is a great deal of seismic activity around Augusta, GA; the Vogtle nuclear plant; and Charleston, SC.**

NRC decision: The NRC staff continues to conclude that the GE Mark I BWRs have been designed, built, and operated to safely withstand earthquakes likely to occur in their region and that the plants meet their current licensing basis. As part of the NRC post-Fukushima lessons-learned activities, the NRC is requiring all licensees to reevaluate seismic hazards at their sites. To this end, on March 12, 2012, the NRC issued a request for information under 10 CFR 50.54(f) (ADAMS Accession No. ML12053A340). Site seismic hazard reevaluation findings by the licensees in the central and eastern United States were submitted in March 2014, and are currently under NRC review. The NRC will take appropriate actions to ensure the continuous safe operation of all the plants, including Vogtle.

In addition, the Commission issued Order EA-12-049 (station blackout mitigation strategies), which requires mitigation strategies to protect against, among many other hazards, postulated seismic events. Such actions significantly enhance the margins of safety to the

effects of beyond-design-basis external events at commercial operating reactors in the United States.

**Request 4: Failure of the Mark I containment even with the hardened vent system at Fukushima Dai-ichi demonstrates the inadequacy in design to mitigate and contain a severe accident resulting from longer station blackout.**

NRC decision: The Commission issued Order EA-12-049, which requires mitigation strategies to protect against, among many other hazards, an extended station blackout. Such actions significantly enhance the margins of safety to the effects of beyond-design-basis external events at commercial operating reactors in the United States.

This order requires a three-phase approach for mitigating beyond-design-basis external events. The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment, and SFP cooling capabilities. The transition phase requires providing sufficient, portable, onsite equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from offsite. The final phase requires obtaining sufficient offsite resources to sustain those functions indefinitely. Order EA-12-049 requires the licensee to meet the following:

- (1) Licensees or construction permit (CP) holders shall develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and SFP cooling capabilities following a beyond-design-basis external event.
- (2) These strategies must be capable of mitigating a simultaneous loss of all ac power and loss of normal access to the ultimate heat sink and have adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to this order.
- (3) Licensees or CP holders must provide reasonable protection for the associated equipment from external events. Such protection must demonstrate that there is

adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to this order.

- (4) Licensees or CP holders must be capable of implementing the strategies in all modes.
- (5) Full compliance shall include procedures, guidance, and training, as well as the acquisition, staging, or installation of equipment needed for the strategies.

The NRC addressed the petitioner's containment venting request through Order EA-12-050, "Order To Modify Licenses with Regard to Reliable Hardened Containment Vents," issued on March 12, 2012 (ADAMS Accession No. ML12054A694), and superseded by a modified Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable for Operation Under Severe Accident Conditions" (ADAMS Accession No. ML13143A334), issued on June 6, 2013.

Order EA-13-109 requires the licensees of BWRs with Mark I and Mark II containments to design and install a venting system that provides venting capability from the wetwell during severe accident conditions. Severe accident conditions include the elevated temperatures, pressures, radiation levels, and combustible gas concentrations, such as hydrogen and carbon monoxide, associated with accidents involving extensive core damage, including accidents involving a breach of the reactor vessel by molten core debris. Furthermore, the licensees of BWRs with Mark I and Mark II containments shall either (1) design and install a venting system that provides venting capability from the drywell under severe accident conditions, or (2) develop and implement a reliable containment venting strategy that makes it unlikely that a licensee would need to vent from the containment drywell during severe accident conditions.

Request 5: **Immediately revoke prior preapproval of the hardened vent system or direct torus vent system at each GE BWR Mark I unit under the provisions of 10 CFR 50.59, "Changes, Tests, and Experiments."**

NRC decision: The NRC finds that existing containment vent systems at BWRs with Mark I containments provide a capability to vent the containment under design-basis circumstances, and their continued operation poses no undue risk to public health and safety. Furthermore, the NRC has required licensees to enhance this capability through Order EA-12-050, "Order to Modify Licenses with Regard to Reliable Hardened Containment Vents," issued on March 12, 2012 (ADAMS Accession No. ML12054A694), and superseded by a modified Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable for Operation under Severe Accident Conditions" (ADAMS Accession No. ML13143A334), issued on June 6, 2013. The petitioner's request has been addressed by these actions. The NRC summarizes the pertinent requirements in these orders above, in response to the petitioner's Request 4.

**Request 6: Immediately issue confirmatory action orders to all GE BWR Mark I units to promptly install safety-related backup electrical power (Class 1E) and additional backup direct current battery system to ensure reliable supply of power for the SFP cooling system.**

NRC decision: The NRC has addressed this request through Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," issued March 12, 2012 (ADAMS Accession No. ML12054A736). This order imposes requirements to maintain or restore SFP cooling capability. This strategy provides makeup water independent of offsite power, normal emergency ac power sources (e.g., installed emergency diesel generators), or normal direct current power sources. This request is also being addressed through rulemaking (mitigation of beyond-design-basis events rulemaking, NRC-2011-0299). The rulemaking, in part, is making generically applicable the requirements of the mitigation strategies order, giving consideration to lessons learned and feedback from implementation of the order's requirements.



**Request 7: Illinois reactors are operating on river flood plains and the current situation in Missouri and Nebraska speaks volumes as to what this means in terms of flooding.**

NRC decision: The NRC staff continues to conclude that the GE Mark I BWRs have been designed, built, and operated to safely withstand flooding likely to occur at each site and meet their current licensing basis. Accordingly, the NRC has decided not to issue orders on flooding at this time. The NRC is instead addressing this issue through a 10 CFR 50.54(f) letter titled, "Request for Information Pursuant to Title 10 of the *Code of Federal Regulations* 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from The Fukushima Dai-ichi Accident" (ADAMS Accession No. ML12056A046), issued on March 12, 2012.

The reasons for this decision are set forth in the following documents. On September 9, 2011, the NRC staff provided SECY-11-0124, "Recommended Actions to Be Taken without Delay from the Near-Term Task Force Report," to the Commission (ADAMS Accession No. ML11245A158). The document identified those actions from the Near-Term Task Force Report that should be taken without unnecessary delay. As part of the staff requirements memo for SECY-11-0124 (ADAMS Accession No. ML112911571) (October 18, 2011), the Commission approved the staff's proposed actions, including the development of three information requests under 10 CFR 50.54(f). The information collected will be used to support the NRC staff's evaluation of whether further regulatory action is needed regarding revisions to the existing flooding licensing basis for each plant.

**Request 8: Provide an expedited hardened (dry cask) onsite storage by emptying the SFPs and converting the irradiated nuclear fuel that is more than 5 years cooled to dry casks. At Fukushima, three reactor systems were blown out and caused exposure of the fuel in the SFPs directly to the atmosphere.**

**The NRC should order TVA to eliminate the existing unsafe irradiated fuel storage system at Browns Ferry and move the fuel to hardened storage in concrete structures.**

NRC decision: Contrary to the petitioner's statement, the SFPs at Fukushima Dai-ichi were found to be structurally intact following the accident and the fuel was still under water, that is, not exposed to the atmosphere.

The NRC would further note that all operating U.S. nuclear power plants store some spent nuclear fuel in "spent fuel pools." These pools are made of reinforced concrete several feet thick, with steel liners. The water is typically about 40 feet (12 meters) deep, and serves both to shield the radiation and cool the spent fuel assemblies.

As the pools near capacity, licensees move some of the older spent fuel into "dry cask" storage. Fuel is typically cooled at least 5 years in the pool before transfer to casks. The NRC has authorized transfer as early as 3 years; the industry norm is about 10 years.

After the September 11, 2001, terrorist attacks, the NRC issued orders to plant operators requiring several measures aimed at mitigating the effects of a large fire, explosion, or accident that damages a SFP. These were meant to deal with the aftermath of a terrorist attack or plane crash; however, they would also be effective in responding to natural phenomena such as tornadoes, earthquakes or tsunamis. These mitigating measures include:

- (1) Controlling the configuration of fuel assemblies in the pool to enhance the ability to keep the fuel cool and recover from damage to the pool.
- (2) Establishing emergency spent fuel cooling capability.
- (3) Staging emergency response equipment nearby so it can be deployed quickly.

The NRC determined that SFPs and dry casks both provide adequate protection of the public health and safety and the environment. Therefore, there is no safety or security reason to mandate earlier transfer of fuel from pool to cask. In a staff requirements memorandum dated May 23, 2014 (ADAMS Accession No. ML14143A360), the Commission directed the NRC staff,

based on the staff's recommendation, to stop working on possible regulatory actions that would require the expedited transfer of spent fuel to dry cask storage. As part of that staff requirements memorandum, the Commission also directed the staff to provide an assessment of limited term operational vulnerabilities associated with SFPs. The staff completed that assessment and provided the results to the Commission on November 26, 2014, in SECY-14-0136 (ADAMS Accession No. ML14297A232). The staff concluded that SFPs are safe and secure and that no additional regulatory action is necessary at this time.

The GE Mark I BWRs meet their current license requirements related to spent fuel storage and inventory. Dry cask storage is in use at Browns Ferry Nuclear Plant, along with SFP storage.

In conclusion, based on the NRC's prior analyses of closely related issues, we conclude there is no need to issue an order requiring licensees to take the petitioner's requested actions.

**Request 9: The intense rainfall accompanying the hurricane thoroughly saturated the ground around Vermont Yankee, which has aggravated the existing problem of reactors' underground safety-related electrical cables that were never designed to withstand wet or underwater conditions. The NRC is aware of this problem. To my knowledge, no remedial action or even a complete inspection of every inch of such cables has been undertaken or is even being contemplated.**

NRC decision: During license renewal of the Vermont Yankee Nuclear Power Station, Entergy Nuclear Operations, Inc. (the licensee), made the following commitments related to the electrical cables as described in the safety evaluation report NUREG-1907, Supplement 2 (ADAMS Accession No. ML110770495).

#### Commitment 13

Implement the Non-Environmental Qualification Inaccessible Medium-Voltage Cable Program as described in License Renewal Application Section B.1.17.

Inspections for water accumulation in manholes containing inaccessible low-voltage and medium-voltage cables with a license renewal intended function will be performed at least once every year. Additional condition-based inspections of these manholes will be performed based on: a) potentially high water table conditions, as indicated by high river level, and b) after periods of heavy rain. The inspection results are expected to indicate whether the inspection frequency should be modified. Inaccessible low-voltage cables (400 V to 2 kilovolt [Kv]) with a license renewal intended function are included in this program. Inaccessible low-voltage cables will be tested for degradation of the cable insulation prior to the period of extended operation and at least once every six years thereafter. A proven, commercially available test will be used for detecting deterioration due to wetting of the insulation system for inaccessible low-voltage cables.

#### Commitment 43

Establish and implement a program that will require testing of the two 13.8 kV cables from the two Vernon Hydro Station 13.8 kV switchgear buses to the 13.8 kV/69 kV step up transformers before the period of extended operation and at least once every 6 years after the initial test.

The NRC Inspection Report 05000271/2012008 dated April 20, 2012 (ADAMS Accession No. ML12103A406) discussed the implementation of Commitments 13 and 14 as noted below.

The inspectors reviewed the commitment completion review reports, manhole inspection results, and cable test results to verify that potential aging effects to inaccessible cables were being adequately managed. The inspectors reviewed tan delta and insulation resistance test results to verify that cable testing frequencies were established based on

cable performance. The inspectors verified that the cable testing program included medium and low voltage cables.

The inspectors also reviewed the manhole inspection results and determined that all of the manholes had been inspected and future work orders were designed to inspect the manholes on appropriate frequencies and at least once every year. The inspectors reviewed OP-PHEN-3127, "Natural Phenomena Operating Procedure," to verify that the manholes will be inspected under conditions of high river level or after heavy rain. The inspectors also interviewed the project manager to review any operating experience or implementation issues.

Commitment 43 applied the Commitment 13 cable testing program to the cables between Vermont Yankee and the Vernon Hydro Station. The inspectors reviewed the cable testing program to ensure that the cables between Vermont Yankee and Vernon Hydro station were included in the cable testing program, the cables had been tested satisfactorily, and the cable testing frequency was set at 6 years.

Based on the above, the licensee has satisfied the commitments made during the license renewal application. The NRC finds that the licensee's existing commitments address the risks identified by the petitioner. In addition, by letter dated January 12, 2015 (ADAMS Accession No. ML15013A426), Entergy Nuclear Operations, Inc. provided certifications in accordance with 10 CFR 50.82(a)(1)(i) and (ii) that the Vermont Yankee Nuclear Power Station (VYNPS) had permanently ceased power operations on December 29, 2014 and that as of January 12, 2015, all fuel had been permanently removed from the reactor vessel and placed in the spent fuel pool.

With the docketing of these certifications, the VYNPS 10 CFR Part 50 license no longer authorizes operation of the reactor or emplacement of fuel in the reactor vessel.

When a nuclear power plant permanently ceases operations and the licensee defuels the reactor, the accident sequences that dominated the operating plant risk are no longer applicable. The primary remaining source of risk to the public is associated with potential accidents that involve the used fuel stored in the spent fuel pool. The NRC staff recognizes that VYNPS will maintain mitigating strategies for the protection of spent fuel pool pursuant to condition 3.N of its license. License condition 3.N requires VYNPS to develop and maintain strategies and staff training to address large fires and explosions that includes protection of the spent fuel pool. The operations staff at VYNPS will continue to receive training on mitigation strategies related to the protection of spent fuel.

Furthermore, the NRC would note that NRC Regulatory Guide 1.218, "Condition-Monitoring Techniques for Electric Cables Used in Nuclear Power Plants," published in April 2012, provides guidelines in monitoring the performance of electric cables used in nuclear power plants. Therefore, an order requiring additional actions by VYNPS is not needed at this time.

### **III. Conclusion**

The NRC has evaluated each of the petitioner's requests. For the reasons stated above, the NRC will not be issuing an order requiring the additional actions specified in the petitioner's requests.

As provided in 10 CFR 2.206(c), a copy of this director's decision will be filed with the Secretary of the Commission for the Commission to review. This decision will constitute the final

action of the Commission 25 days after the date of the decision unless the Commission, on its own motion, institutes a review of the decision within that time.

Dated at Rockville, Maryland, this 15<sup>th</sup> day of January, 2015.

For the Nuclear Regulatory Commission.

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Jennifer L. Uhle, Deputy Director  
for Reactor Safety Programs  
Office of Nuclear Reactor Regulation